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Economic Possibilities of Shipping though Northern Sea Route

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Contents

Abstract

Global warming and climate change haves brought a new issue in the Arctic sea. Therefore, we can now explore new shipping routes through the Arctic Ocean instead of the existing commercial route. In particular, the Northern Sea Route (NSR) is one of the feasible shipping routes and, has provided tremendous shipping benefits. If the NSR becomes commercialized, we will be able to save about 5,000 nautical miles in distance and sailing time. In this study, we will emphasize some of the important results on the possibility of commercializing the shipping route in the Arctic. The NSR may bring positive economic effects in terms of shipping distance and time. For example, when utilizing the NSR, the maximum cargo traffic between Asia and Europe is expected to be around 46 million TEU. However, we also need to consider an expensive passage fee that is currently imposed by Russia. In conclusion, we maintain our efforts to protect the environment in the Arctic, in terms of logistics, and we need to explore every possible avenue to bring possible economic benefits to the North Pacific countries.

Key words : Northern Sea Route, Arctic Sea, O/D Analysis, SP Survey

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I. Introduction

Global warming has been one of the main factors directly affecting our lives and the environment. The effects of climate change and global warming have brought new issues in the Arctic sea area once this area started experiencing a profound transformation of ice meltdown. The effects of climate change and global warming since 1970 have begun to experience a change in the deep collapse of ice. Since then, the region has led to a new problem in the Arctic sea area. This enabled us to explore a new shipping route through the Arctic instead of the previously existing commercial shipping routes. Particularly, the Northern Sea Route (hereinafter called 'NSR'), which is located between the North Atlantic and the Northern Pacific along the Arctic sea, is gradually becoming one of the more feasible international shipping routes. After 2010, there was a keen rise in the number of ships passing through the NSR, and is expected to bring even more vessels in 2014.[1] The shipping frequencies of the NSR will increase with tremendous benefits. If the NSR becomes utilized, it can save about 5000 nautical miles and weekly shipping time compared to the existing routes via the Suez Canal.

Despite of its importance, we have not paid attention to the preparation works on how to bring the issue of realizing the commercialization of the NSR into the academic field. There have been some studies on the Arctic's sea ice extent, but only a few studies such as Verny (2009),[2] Liu and Kronbak (2010)[3]. Especially, the specific data, information and condition on how long and often we can ship via this route has yet to available. In this respect, this paper will analyze around cargo containers in order to easily understand the commercialization of the NSR.

Having the aforementioned in mind, this research will discuss how the NSR can benefit East Asian countries and global shipping companies in terms of logistics, cargo traffic, economical effect and the development of natural resources. This study consists of 4 chapters. Chapter 2 will address the evaluation of distance and time-saving effects by using the NSR. Chapter 3 will examine the possible scenarios of container shipping via the

1) Twice in 2011, 46 times in 2012, and is rapidly increasing such as 72 times in 2013. (Source : Rosatomflot, http://www.rosatomflot,ru)

2) Verny(2009)

3) Liu and Kronbak(2010), pp.434-444.

NSR in the targeted regions through the origin and destination (O/D) analysis. In chapter 4, we will provide the advantage of frame with verified resources of the ship utilizing the NSR, summarizes our main results, and suggest conclusions.

II. Evaluating Savings in Distance and Time by Using NSR

1. Selecting a Target Area

One of the most representative routes that were proved to save shipping distance via the NSR is the one from Yokohama, Japan to Rotterdam in Europe. In this study, we are going to examine the specific countries benefited from the distance-saving effects via the NSR in their geographic scope.

First, we have divided Europe into three geographic scopes. We have nine countries along the Scandinavian/Baltic Sea: Norway, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland and Denmark and seven countries in Northern Europe: Iceland, Germany, Netherland, Belgium, UK and France. Also, we have considered the representative ports of three countries on the Iberian Peninsula and west Mediterranean sea, Portugal, Spain, and Italy. As for Asia, we have considered eight major ports in China, Korea, Japan, Taiwan, HongKong, Philippines, Cambodia, Thailand, Singapore and Indonesia. In other words, we have selected the Northwest region in Europe and countries on the right side of Singapore in Asia.

The shipping distance from the ports in the selected countries to the Suez Canal can be measured by the Netpas program[3)] designed to professionally measure shipping routes. However, we still have difficulty in measuring the distance of the NSR since the commercial use of the NSR has not yet been undertaken. So far, we have a research result of 3,184NM measured for the distance between the westernmost part of the routes, Murmansk and the easternmost port, Provideniya. Therefore, if we add the

3) The Nepas Distance Program is the world's port distance table supporting more than 12000 ports and 72 million in distance. With the Netpas Distance, users can get port distances with checking the route on an e-world map. Users can edit their own route and draw another route. It will provide them with real time routes on the map. Users can even calculate simple voyage estimation, developed by the Smart Maritime Business.

distance from European ports to Murmansk, 3,184NM, and the one from Provideniya to Asian ports by the Netpas program, we can derive the total shipping distance via the NSR.[4)]

2. Distance-Saving Effects via the NSR

We are able to derive a distance-saving effect by following the above logic. The route from China turned out to save the shipping distance to the region along the Scandinavian/Baltic Sea and eight major ports in Northern Europe. From Portugal on Iberian Peninsula and the west Mediterranean Sea, shipping distance can be reduced to five ports from Dalian to Ningbo[5)]. Busan, Korea can benefit from the distance-saving effects to Lisbon, Portugal and Japan can also see a positive result for shipping to Valencia, Spain.

<Table 1> Saved shipping distance by NSR

Unit: NM

Category		China								Korea	Japan
		Dalian	Tianjin	Qingdao	Shang-hai	Ningbo	Xiamen	Shen-zhen	Guang-zhou	Busan	Tokyo
Russia	St Petersburg	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,706	4,464
Poland	Gdynia	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,706	4,464
Sweden	Gothenburg	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,706	4,464
Norway	Oslo	3,356	3,348	3,254	3,016	2,992	2,055	1,536	1,536	3,737	4,495
Denmark	Aarhus	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,706	4,464
Finland	Helsinki	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,706	4,464
Estonia	Tallinn	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,716	4,464
Latvia	Riga	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,716	4,464
Lithuania	Klaipeda	3,325	3,317	3,223	2,986	2,961	2,024	1,505	1,505	3,716	4,464
Iceland	Reykjavik	3,397	3,389	3,295	3,057	3,033	2,096	1,577	1,577	3,787	4,536
Germany	Bremen/ Bremerhaven	2,992	2,984	2,890	2,652	2,628	1,690	1,172	1,172	3,373	4,131
Nether-lands	Rotterdam	2,701	2,693	2,599	2,361	2,337	1,400	881	881	3,082	3,840
Belgium	Antwerp	2,629	2,621	2,527	2,289	2,265	1,328	809	809	3,010	3,768
UK	Felixstowe	2,621	2,614	2,519	2,282	2,257	1,320	801	801	3,002	3,760
Ireland	Dublin	2,487	2,479	2,385	2,147	2,123	1,185	667	667	2,868	3,626
France	Le Havre	2,343	2,336	2,241	2,004	1,980	1,042	524	524	2,725	3,483
Portugal	Lisbon	682	675	580	343	319	-619	-1,138	-1,138	1,063	1,822

4) Mulherin(1996)
5) Interview material of NHK(2010)

Spain	Valencia	-520	-527	-622	-859	-884	-1,821	-2,340	-2,340	-139	620
Italy	Gioia Tauro	-1,864	-1,871	-1,966	-2,203	-2,227	-3,165	-3,683	-3,683	-1,482	-724

Source: Authors, created by using Netpas program(2011) and Mulherin(1996)

Other than the areas of Korea, China and Japan, other benefiting countries from these distance-saving effects are Taiwan, HongKong, and the Philippines which can get shorter shipping routes up to the region along the Scandinavian/Baltic Sea and Northern Europe. However, Vietnam, Cambodia, Thailand, Singapore, and Indonesia turned out to have no effect on saving distance.

<Table 2> Saved shipping distance by NSR (ʻcont)

Unit : NM

Category		Taiwan Kaohsiung	Hong Kong	Philippines Manila	Vietnam Ho Chi Minh	Cambodia Sihanou-kville	Thailand Lame Chabang	Singapore	Indonesia Tanjung Priok
Russia	St Petersburg	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Poland	Gdynia	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Sweden	Gothenburg	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Norway	Oslo	1,990	1,566	1,230	-331	-372	-415	-1,177	-187
Denmark	Aarhus	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Finland	Helsinki	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Estonia	Tallinn	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Latvia	Riga	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Lithuania	Klaipeda	1,959	1,535	1,199	-362	-403	-446	-1,208	-218
Iceland	Reykjavik	2,031	1,607	1,271	-290	-331	-374	-1,136	-146
Germany	Bremen/ Bremerhaven	1,625	1,202	865	-696	-736	-779	-1,541	-552
Nether-lands	Rotterdam	1,335	911	575	-986	-1,027	-1,070	-1,832	-842
Belgium	Antwerp	1,263	839	503	-1,058	-1,099	-1,142	-1,904	-914
UK	Felixstowe	1,255	832	495	-1,066	-1,107	-1,150	-1,912	-922
Ireland	Dublin	1,121	697	360	-1,200	-1,241	-1,284	-2,046	-1,056
France	Le Havre	977	554	217	-1,344	-1,385	-1,427	-2,190	-1,200
Portugal	Lisbon	-684	-1,107	-1,444	-3,005	-3,046	-3,088	-3,851	-3,400
Spain	Valencia	-1,886	-2,309	-2,646	-4,207	-4,248	-4,291	-5,053	-3,524
Italy	Gioia Tauro	-3,230	-3,653	-3,990	-5,551	-5,592	-5,634	-6,396	-5,407

Source: Authors, created by using Netpas program(2011) and Mulherin(1996)

3. Time-Saving Effects via the NSR

There are also conflicting opinions that the distance-saving effects do not fully guarantee the reduction of shipping time. The main reason behind this opinion is that the vessel speed can remarkably fall in the ice-water section in the Arctic. In general, we apply 18 nautical miles per hour as a fuel efficient speed of container ships. However, we need to adjust the sailing speed to 3 nautical miles per hour in the ice-water section in order to gain stability for shipping operation and its noise level.[6)]

In addition, if we assume that non-ice water in the Arctic sea will be open for three months[7)] and enables us to ship through the NSR, then we can apply 700 nautical miles in ice water length. If the route is open for six month, we will then apply 300 nautical miles in ice water length, and lastly, we will put zero nautical miles if it is open all year round.

Based on this assumption, we can estimate the shipping time-saving effects as seen in table 3. All of the Chinese ports do not have any time-saving effect if the NSR is available only for three months. In addition, Korea only has a minimal time-saving effect of less than one day for the Scandinavian/Baltic Sea and Northern Europe bound. In the case of Japan, one to two days can be saved if it ships to countries located on the Northern side of France.

<Table 3> Saved shipping time by NSR: 3 month sailing

Unit: Days

Category		China								Korea	Japan
		Dalian	Tianjin	Qingdao	Shang-hai	Ningbo	Xiamen	Shen-zhen	Guang-zhou	Busan	Tokyo
Russia	St Petersburg	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.6	0.5	2.2
Poland	Gdynia	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.6	0.5	2.2
Sweden	Gothenburg	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.6	0.5	2.2
Norway	Oslo	-0.3	-0.4	-0.6	-1.1	-1.2	-3.3	-4.6	-4.6	0.5	2.2
Denmark	Aarhus	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.6	0.5	2.2
Finland	Helsinki	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.6	0.5	2.2
Estonia	Tallinn	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.6	0.5	2.2
Latvia	Riga	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.6	0.5	2.2
Lithuania	Klaipeda	-0.4	-0.4	-0.6	-1.2	-1.2	-3.4	-4.6	-4.5	0.5	2.2

6) It is expected by the technological advances of the future, operating speed of the ice breaker in the section is increased, In this study, to estimate the reduction time based on the speed of the current

7) Assuming that the ice-water section route of three months is available to be about 700 NM

Iceland	Reykjavik	-0.2	-0.3	-0.5	-1.0	-1.1	-3.3	-4.5	-4.5	0.7	2.4
Germany	Bremen/ Bremerhaven	-1.2	-1.2	-1.4	-2.0	-2.0	-4.2	-5.4	-5.4	-0.3	1.5
Nether-lands	Rotterdam	-1.8	-1.9	-2.1	-2.6	-2.7	-4.9	-6.1	-6.1	-1.0	0.8
Belgium	Antwerp	-2.0	-2.0	-2.3	-2.8	-2.9	-5.0	-62	--6.2	-1.1	0.6
UK	Felixstowe	-2.0	-2.0	-2.3	-2.8	-2.9	-5.0	-6.2	-6.2	-1.1	0.6
Ireland	Dublin	-2.3	-2.4	-2.6	-3.1	-3.2	-5.4	-6.6	-6.6	-1.5	0.3
France	Le Havre	-2.7	-2.7	-2.9	-3.5	-3.5	-5.7	-6.9	-6.9	-1.8	-0.0
Portugal	Lisbon	-9.3	-9.3	-9.5	-10.1	-10.1	-12.3	-15.5	-13.5	-8.4	-5.7
Spain	Valencia	-9.3	-9.3	-9.5	-10.1	-10.1	-12.3	-13.5	-13.5	-8.1	-6.7
Italy	Gioia Tauro	-12.4	-12.4	-12.7	13.2	-13.3	-15.4	-16.6	-16.6	-11.5	-9.8

Source: Lee et al.(2011); This analysis is based on Netpas program(2011)

Taiwan, Hong Kong and the Philippines do not benefit from the time-saving effect via the NSR if the Arctic sea is open for only three months.

<Table 4> Saved shipping time by NSR: 3 month sailing ('cont)

Unit : Days

Category		Taiwan Kaohsiung	Hong Kong	Philippines Manila	Vietnam Ho Chi Minh	Cambodia Sihanou-kville	Thailand ame Chabang	Singapore	Indonesia Tanjung Priok
Russia	St Petersburg	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Poland	Gdynia	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Sweden	Gothenburg	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Norway	Oslo	-3.5	-4.5	-5.3	-8.9	-9.0	-9.1	-10.8	-9.6
Denmark	Aarhus	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Finland	Helsinki	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Estonia	Tallinn	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Latvia	Riga	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Lithuania	Klaipeda	-3.6	-4.5	-5.3	-8.9	-9.0	-9.1	-10.9	-9.7
Iceland	Reykjavik	-3.4	-4.4	-5.2	-8.8	-8.9	-9.0	-10.7	-9.5
Germany	Bremen/ Bremerhaven	-4.3	-5.3	-6.1	-9.7	-9.8	-9.9	-11.7	-10.4
Nether-lands	Rotterdam	-5.0	-6.0	-6.8	-10.4	-10.5	-10.6	-12.3	-11.1
Belgium	Antwerp	-5.2	-6.2	-6.9	-10.6	-10.6	-10.7	-12.5	-11.3
UK	Felixstowe	-5.2	-6.2	-7.0	-10.6	-10.7	-10.8	-12.5	-11.3
Ireland	Dublin	-5.5	-6.5	-7.3	-10.9	-11.0	-11.1	-12.8	-11.6
France	Le Havre	-5.8	-6.8	-7.6	-11.2	-11.3	-11.4	-13.2	-11.9
Portugal	Lisbon	-9.7	-10.7	-11.4	-15.1	-15.2	-15.3	-17.0	-15.8
Spain	Valencia	-12.5	-13.4	-14.2	-17.8	-17.9	-18.0	-19.8	-18.6
Italy	Gioia Tauro	-15.6	-16.6	-17.3	-21.0	-21.0	-21.1	-22.9	-21.7

Source: Lee et al.(2011); This analysis is based on Netpas program(2011)

However, if we assume the Arctic sea is open all year round, then the vessel can operate at the speed of 18 nautical miles per hour for all the routes in the NSR. This can actually convert a distance-saving effect of the NSR to a positive time-saving effect. The Chinese ports from Dalian to Ningbo can save shipping time to Northern Europe above France as much as about five to eight days. Busan, Korea can reduce its shipping time to France approximately six to nine days and Japan can also benefit from eight to ten days from the time-saving effects by using the NSR.

<Table 5> Saved shipping time by NSR in case of 12 month sailing

Unit: Days

Category		China								Korea	Japan
		Dalian	Tianjin	Qingdao	Shang-hai	Ningbo	Xiamen	Shen-zhen	Guang-zhou	Busan	Tokyo
Russia	St Petersburg	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Poland	Gdynia	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Sweden	Gothenburg	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Norway	Oslo	7.8	7.8	7.5	7.0	6.9	4.8	3.6	3.6	8.7	10.4
Denmark	Aarhus	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Finland	Helsinki	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Estonia	Tallinn	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Latvia	Riga	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Lithuania	Klaipeda	7.7	7.7	7.5	6.9	6.9	4.7	3.5	3.5	8.6	10.3
Iceland	Reykjavik	7.9	7.8	7.6	7.1	7.0	4.9	3.7	3.7	8.8	10.5
Germany	Bremen/ Bremerhaven	6.9	6.9	6.7	6.1	6.1	3.9	2.7	2.7	7.8	9.6
Nether-lands	Rotterdam	6.3	6.2	6.0	5.5	5.4	3.2	2.0	2.0	7.1	8.9
Belgium	Antwerp	6.1	6.1	5.8	5.3	5.2	3.1	1.9	1.9	7.0	8.7
UK	Felixstowe	6.1	6.0	5.8	5.3	5.2	3.1	1.9	1.9	6.9	8.7
Ireland	Dublin	5.8	5.7	5.5	5.0	4.9	2.7	1.5	1.5	6.6	8.4
France	Le Havre	5.4	5.4	5.2	4.6	4.6	2.4	1.2	1.2	6.3	8.1
Portugal	Lisbon	1.6	1.6	1.3	0.8	0.7	-1.4	-2.6	-2.6	2.5	4.2
Spain	Valencia	-1.2	-1.2	-1.4	-2.0	-2.0	-4.2	-5.4	-5.4	-0.3	1.4
Italy	Gioia Tauro	-4.3	-4.3	-4.6	-5.1	-5.2	-7.3	-8.5	-8.5	-3.4	-1.7

Source: Lee et al.(2011); This analysis is based on Netpas program(2011)

Taiwan, Hong Kong and the Philippines will have one to five days saving effects to countries located to the north of France.

<Table 6> Saved shipping time by NSR in case for 12 month sailing ('cont)

Unit : Days

Category		Taiwan Kaohsiung	Hong Kong	Philippines Manila	Vietnam Ho Chi Minh	Cambodia Sihanou-kville	Thailand Lame Chabang	Singapore	Indonesia Tanjung Priok
Russia	St Petersburg	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Poland	Gdynia	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Sweden	Gothenburg	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Norway	Oslo	4.6	3.6	2.8	-0.8	-0.9	-1.0	-2.7	-1.5
Denmark	Aarhus	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Finland	Helsinki	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Estonia	Tallinn	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Latvia	Riga	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Lithuania	Klaipeda	4.5	3.6	2.8	-0.8	-0.9	-1.0	-2.8	-1.6
Iceland	Reykjavik	4.7	3.7	2.9	-0.7	-0.8	-0.9	-2.6	-1.4
Germany	Bremen/ Bremerhaven	3.8	2.8	2.0	-1.6	-1.7	-1.8	-3.6	-2.3
Nether-lands	Rotterdam	3.1	2.1	1.3	-2.3	-2.4	-2.5	-4.2	-3.0
Belgium	Antwerp	2.9	1.9	1.2	-2.4	-2.5	-2.6	-4.4	-3.2
UK	Felixstowe	2.9	1.9	1.1	-2.5	-2.6	-2.7	-4.4	-3.2
Ireland	Dublin	2.6	1.6	0.8	-2.8	-2.9	-3.0	-4.7	-3.5
France	Le Havre	2.3	1.3	0.5	-3.1	-3.2	-3.3	-5.1	-3.8
Portugal	Lisbon	-1.6	-2.6	-3.3	-7.0	-7.1	-7.1	-8.9	-7.7
Spain	Valencia	-4.4	-5.3	-6.1	-9.7	-9.8	-9.9	-11.7	-10.5
Italy	Gioia Tauro	-7.5	-8.5	-9.2	-12.8	-12.9	-13.0	-14.8	-13.6

Source: Lee et al.(2011); This analysis is based on Netpas program(2011)

III. Examining Possible Scenarios of Container Shipping by Using the NSR

1. Setting up Scenarios of Using the NSR with Variables of Time and Cost

We have conducted a Stated Preference (SP) survey in order to gain the expected shares of using the ESR and NSR in the future. The SP survey is a method that provides better estimates by asking respondents to select choices or their prioritize options by a particular scenario that has yet to happen. In other words, under conditions if there are no existing data, then other methods such as traffic volume and throughput are utilized to predict when developing new transportation and port facilities.

The advantage of SP survey is that the researchers can control the status of the experiment. Moreover, it is possible to keep the analyzed data

independent. However, the disadvantages of the SP survey show its limitation in its-surveying method. There is The 'affirmation bias' which allows the respondents to interpret the questionnaire that confirms with their own conscious and unconscious, 'Rationalization bias' is how respondents are able to provide artificial answers try to rationalize the behavior of their actions. The 'policy response bias', makes the respondents believe their responses will affect their decision making and therefore respond accordingly. Finally, the 'unconstrained response bias', causes the respondents to ignore the constraints of facts and respond unrealistically. For these reasons, in order to overcome the disadvantage of SP survey, hypothetical situation which should be designed to resemble the real conditions.

The survey participants consisted of forwarders and logistics companies excluding shipping liners. We also excluded manufacturing companies since their understanding level on using the NSR is currently low and this can possibly ruin the accuracy of the survey. Also, shipping liners are excluded from this survey due to their characteristics that can open up new shipping routes following the shipper's demands.

The factors we took into consideration are costs and time which are the most important factors when it comes to choosing a shipping route. Besides these two, we excluded some other factors such as sea waves in the Arctic, port infrastructures, the stability of shipping operation, shipping regularity, how to secure the supply of vessel items, and whether the oil supply bases and port services are available. This is because it is difficult to convert this data into specific numbers and the complexity of the questionnaire can ruin the accuracy of the responses making the respondent not fully understanding the questions.

As for the scenarios with time variables, we need to consider the maximum 10 days saving effects brought on by using the NSR shown in the case of Japan. Therefore, we have set up three scenarios: a zero time-saving effect as similar to the current level, the five days saving effect, and the ten days saving effect. As for the scenarios by costs, we have considered of advices from experts on asymmetric demand price elasticity. Therefore, we have set up five scenarios, spreading out the shipping costs of the NSR by 120 percent, 110 percent, 100 percent, 80 percent and 70 percent of the costs for the existing Suez Canal Route. based on Lee,

et.al's study (2011)[8].

The next table shows the result of analysis of the SP survey. We asked the respondents their willingness to use the NSR by varying its cost and time conditions under the assumption that the cost per TEU is fixed at 1,000~1,500 dollars per TEU (or unit costs) and the NSR is open for 30 days.

The analysis indicates that the share of the NSR is expected to be about 20 percent if the shipping time through the NSR stays at the same level with one utilizing the South Cross Route (SCR). If the shipping time through the NSR is saved to 5 days with the same shipping costs taken for the SCR, the share of the NSR will be about 72 percent. Also, it turns out 96 percent of the respondents will choose the NSR if they can save 10 days under the condition of the same costs taken for the SCR.

<Table 7> NSR shares by scenario

NSR Cost	NSR Time	NSR Shares
120%	30days	1%
110%	30days	5%
100%	30days	20%
80%	30days	86%
70%	30days	97%
120%	25days	10%
110%	25days	34%
100%	25days	72%
80%	25days	98%
70%	25days	100%
120%	20days	52%
110%	20days	84%
100%	20days	96%
80%	20days	100%
70%	20days	100%

Source: Lee et al.(2011)

8) Lee(2011)

2. Forecasted Traffic Volume via the NSR

The cost analysis of the NSR and the SCR can be complicated due to many other factors that can affect the cost. However, we can utilize the already driven numbers in the previous section for the time-saving effects of the NSR.

The time-saving effects via the NSR highly rely on the length of ice-class section on the Arctic, as well as depending on how long the NSR can be open. There has been no available data for the opening period of the NSR year by year. However, according to the Arctic Council (AMSA) (2009), it is forecasted that the NSR would be open about 90 to 100 days by 2080. Ragner (2008)[9] mentioned the possibility that the Arctic sea would be open for 170 days at maximum in 100 years, as the technology evolves. Mark Serreze at NSIDC in the US predicted that the Arctic's ice will completely be melted by 2030 if we keep the current trend. In addition, the current ice extent as of July, 2011 has been observed to be even lower than it was during the same period in 2007, showing no sign of slowing down its melting speed.

In this respect, we applied three stages of opening of the Arctic: three months in 2015, six months in 2020, and nine months in 2025, taking a prospective that the NSR will be commercialized by 2030. We put the expected saved time using the routes to Europe from six Asian countries into these scenarios, and estimated the ports of container traffic share of the NSR, as seen on table 8. The container traffic is forecasted to reach about 29,000TEU in 2015 and around 3 million TEU in 2030. The share of the NSR would be 1.6 percent in 2015 and 64.1 percent in 2030 under the condition that the sailing cost through the NSR stays at the same level with the cost of the SCR.

<Table 8> Container Traffic Forecast and Share of NSR

Unit : 1,000 TEU

NSR Cost	Share			
	2015	2020	2025	2030
120%	0.1%	1.2%	4.6%	9.7%
110%	0.3%	5.0%	16.9%	31.6%

9) Along the research content Liu and Kronbak (2009), the length of the ice-water interval based on the operational period was applied, 3 months 700NM, 6 months 300NM, 9months 100NM.

100%	1.6%	16.0%	40.2%	64.1%
80%	13.3%	43.3%	69.7%	94.5%
70%	20.2%	47.3%	72.1%	96.4%

Source: Lee et al.(2011)

For further studies related to the shipping of the NSR, we need to analyze the cost price for shipping and have to recognize that critical issues comes from not only the high level of oil price, but also from how much the ice breaking fees will be imposed. Because the Arctic route is still in its infancy, measurements about various risk have not been performed accurately. It is necessary to estimate the shipping insurance and we also need to continue our study.

IV. Concluding Remarks

Due to global warming and the progressive lifting of technical constraints on navigation, the era of opening the NSR will come indefinitely in the near future. An increase of sea trade volume resulting from deepening globalization, international specialization and extending FTA reinforces the advantages of the NSR. Another reason to utilize the NSR comes from the fact that the entire industrialized world has pushed to explore the untapped natural resources in the Arctic sea area[10]. In this respect, this study addresses the possibility of commercial use of the route based on the current data of shipping operation based on some assumptions. It also highlights some important findings on the feasibility of container shipping via the NSR.

The findings of this paper are as follows:

(a) The NSR has economic effects in terms of distance and time, but we also need to consider the factor of expensive NSR toll fees imposed by

10) Lee(2103), pp.310-318.

Russia. A key issue lies in whether the NSR till become a popular shipping route or not because of this heavily imposed fee.

(b) The SP survey collected replies from 20 percent of the respondents, Korean shippers and forwarders. 72 percent of them acknowledged the use of the NSR if it can save 5 days and 96 percent of them said they would choose the NSR if it can bring 10 days saving effects.

In this context, we need to discuss the appropriate toll level in order to commercialize the NSR as a common shipping route. In addition, we expect to reduce CO_2 levels to protect the global environment as well as to gain and economical effect if the level of ice breaking fees stays at a reasonable level.

We hope to make a few suggestions by summing up the result of this study. First, we need to discuss more on how to keep the toll fees at the appropriate level for the commercial use of the NSR as mentioned above. Second, we need to establish laws, i.e. UNCOLOS (United Nations Convention on the Law of the Sea) and the Polar Code[11], and an amendment system related to the NSR. Third, we need to develop an appropriate vessel for the NSR as early as possible. Fourth, we need to establish a global cooperation to reinvigorate the use of the NSR. Fifth, we need to develop a sailor training program for the NSR. Lastly, we need to develop appropriate ports along the coastal area in the Arctic. In this study we tried to understand how to make the commercialization of the NSR feasible in terms of container cargo. However we are still facing a number of weakness and limitations in doing this. As the economic situation continuously evolves, any results driven by the analysis in this study are subject to change. The expenses can vary according to the shipping operation costs, Moreover, other factors may always change depending on the uncontrollable external factors such as oil price, supply and demand of vessels, political situation, effective environmental protection policy, the level of technology, etc. For this reason, we have faced difficulties in addressing and delivering an accurate result.

Second, this survey is limited in terms of the number of respondents replying to the survey was only 73. The sensitivity for time and costs of the shippers and forwarders differs depending on where the companies are located. Thus, we need to cover more respondents from region to region in

11) The International Maritime Organization (IMO) has revised polar code of Guidelines for Ships Operating in Polar Waters (2009) for environmental protection and maritime safety in the Arctic by 2015.

order to gain more accuracy.

Third, we only considered two variables: time and costs. There can be other factors in reality such as shipping regularity and port infrastructure that actually influence the decision-making of shippers and forwarders.

NSR shipping is already initiated by destination shipping like bulk, and then the transit shipping like container has become commercialized after generalizing destination shipping. All reasons are related to economic benefit. Therefore, we hope that more qualitative and quantitative studies will be completed in order to find the economic solution and utilize the NSR to overcome the limitations we are currently facing.*

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